Appendix C

PALM BEACH HARBOR DISPOSAL AREA STUDY

PALM BEACH HARBOR

DISPOSAL AREA STUDY

PALM BEACH HARBOR
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INTRODUCTION

The Jacksonville District of the U.S. Army Corps of Engineers performed this study to determine the availability of upland sites in the vicinity of Palm Beach Harbor for disposal of dredged material. The purpose of the study was to determine the availability and feasibility of using upland sites in comparison to offshore dredged material disposal for Palm Beach Harbor. Upland disposal sites underwent an analysis of environmental, engineering, and economic criteria. The economic assessment included the cost to purchase the required land, construct the necessary features, and transport the dredged material to the site. The analysis involves environmental and economic impacts of offshore and upland disposal to obtain a cost comparison which would indicate the most feasible method of disposal. The analysis and evaluation presented in this study include information and conditions existing during the latter half of 1994. Further, more detailed study would be required to implement any upland site recommended in this report.

As this study is primarily for the disposal of dredged material from the Palm Beach Harbor Federal Project, the Federal navigation channel was the major concern. Any material dredged from local access channels and berthing areas was not a consideration at this time. The Intracoastal Waterway - Jacksonville to Miami (IWW) was also excluded from this study as it is not part of the Palm Beach Harbor Federal Project. The IWW crosses Palm Beach Harbor turning basin in Lake Worth. It provides a channel depth of 10 feet over a bottom width of 125 feet. Therefore, portions of the IWW and Palm Beach Harbor Federal projects overlap. The deeper depths of Palm Beach Harbor are maintained in the overlap area (turning basin). The IWW has disposal sites for future maintenance work. Figure 1 is provided to show the location of Palm Beach Harbor. Figure 2 is provided to show the location of the maintenance areas (shoals).

INITIAL INVESTIGATIONS

Initial investigations centered on obtaining and reviewing any previous disposal area studies for Palm Beach and other harbors. Recent aerial maps of Palm Beach County were inspected to determine the availability of upland disposal areas within a ten mile arc from the Palm Beach Harbor Turning Basin. Prior studies and reports provided a methodology for an upland area evaluation which included environmental, engineering and economic considerations. Information from several reports on Palm Beach Harbor (Survey-Review Report, General and Detail Design Memorandums, and Feasibility Report and Environmental Assessment) and the Port Everglades Harbor Disposal Area Study were helpful in preparing for this analysis and understanding the problems associated with dredged material disposal.

SHOAL CHARACTERISTICS

The initial analysis involved a determination of dredged material quantity and classification as well as the dredging interval for the entrance channel and turning basin of the harbor. A dredging history on the Federally constructed entrance channel and main turning basin is available in the Jacksonville District Office. That history contains the quantity of material removed from the entrance channel and turning basin during each dredging event with a recorded time frame. Analysis of the data determined the annual shoaling rate and dredging interval for the entrance channel and turning basin in the harbor. After determination of the annual shoaling rate and dredging interval, an analysis of the Palm Beach Harbor maintenance dredging history determined the location and average depth of shoals within the entrance channel, inner channel and turning basin. Shoal material from the inner and entrance channels has been utilized for beach nourishment and was not included in this study. Shoal quantity, surface area, and depth are important factors related to dredging costs for shoal removal. The results of that analysis are presented in table 1.

SITE IDENTIFICATION

Selection Criteria - To enable potential site identification, specific criteria was established with regard to size, shape, use, and boundary conditions. Potential sites less than 10 acres in size or with any dwelling were not considered for an upland disposal area. Wetlands or other environmentally sensitive areas were also avoided as potential sites. For any small site, shape would be a consideration to enable sufficient settling time

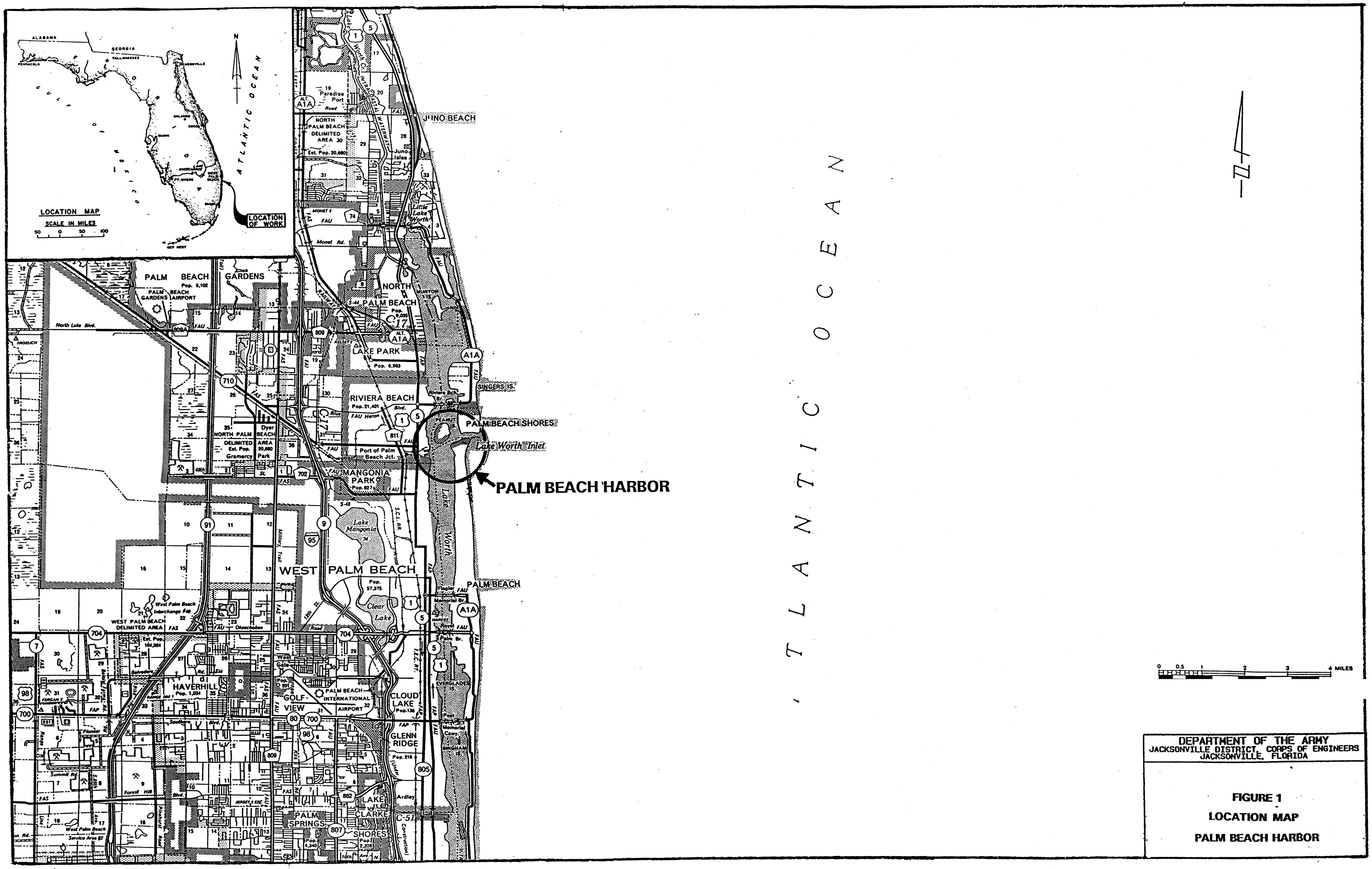

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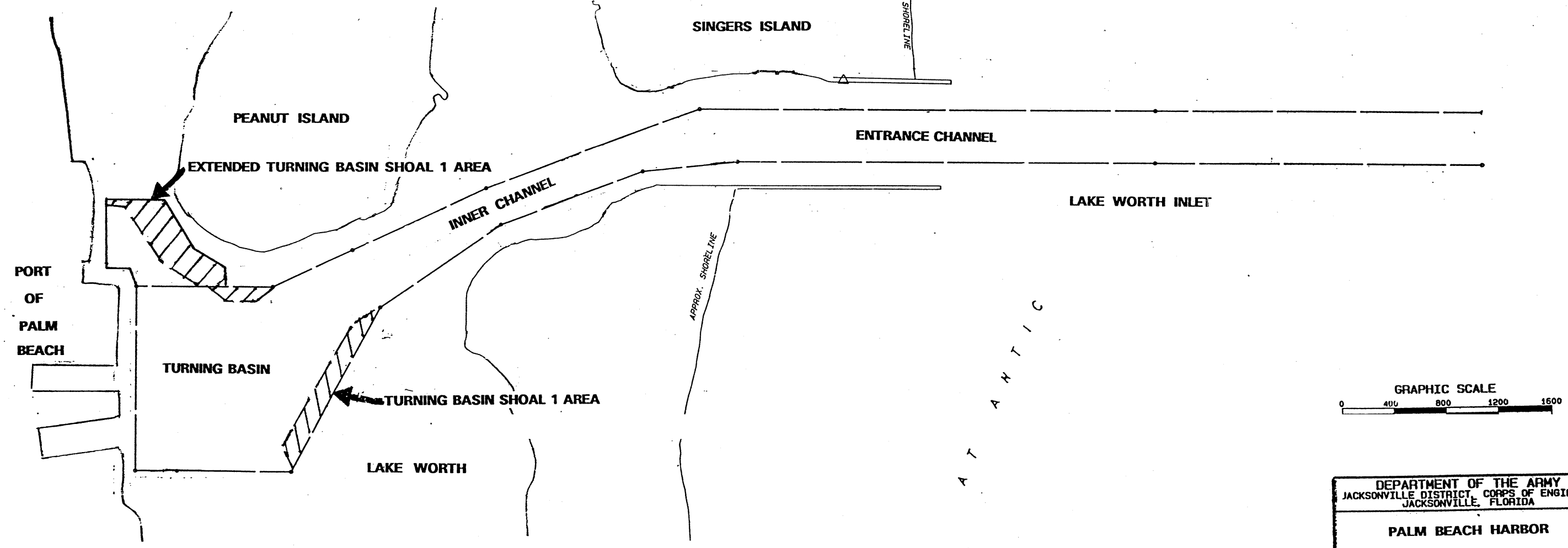
FIGURE 1

LOCATION MAP

PALM BEACH HARBOR



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PALM BEACH HARBOR

FIGURE 2

LOCATION MAP

MAINTENANCE AREAS

TABLE 1
PALM BEACH HARBOR
HARBOR SECTIONS AND
SHOAL CHARACTERISTICS

SECTION NAME	DEPTH (FEET)	SECTION LENGTH (FEET)	ANNUAL SHOALING (CY)	DREDGE INTERVAL (YEARS)	TOTAL QUANTITY (CY)	SURFACE AREA (FEET ^ 2)	PROJECTED SHOALING (FEET)	MATERIAL TYPE
TURNING BASIN								
SHOAL 1	33	1,650	5,300	3	15,900	43,500	9.9	SAND & SILT
EXTENDED TURNING BASIN								
SHOAL 1	25	1,150	5,000	12	60,000	203,000	7.9	SAND & SILT

for the return water to meet required water quality standards. Property boundaries influenced site selection because severance damages are a consideration in real estate values. Severance damages are paid to aproperty owner when purchasing a portion of a parcel of land that devalues the remaining sections. In designating potential sites, utilization of the entire parcel was a major consideration to avoid any additional severance costs. With the criteria in place, the selection process went forward to identify the geographical boundaries as a means of limiting the scope of the search.

Geographical Boundaries - The identification of initial geographical boundaries usually involves a consideration for pipeline access to any potential site. The shoreline at the Atlantic Ocean forms the eastern limit. Equipment limitations relating to pumping dredged material to potential sites define the southern, western and northern boundaries. The detailed dredging analysis identifies a maximum pumping distance for this study as approximately 10 miles from the hydraulic dredge plant location. The pumping limit of 10 miles is based primarily on equipment limitations such as pipeline availability. Some respected experts in the dredging field consider only a 5 mile maximum pumping distance as reasonable based upon the availability of pipeline. For this study, however, the limit was extended to ensure all possible alternatives for upland locations in the vicinity of Palm Beach Harbor received full consideration. Geographical boundaries and equipment limitations greatly reduced the extent of potential site locations.

Site Selection - REDI maps with aerial photography dated 1992 of Palm Beach County available in the Jacksonville District, U.S. Army Corps of Engineers, Regulatory Division Office were of assistance in determining potential upland disposal site locations. These REDI maps were accessible for inspection in volumes covering the northern, central, and southern portions of Palm Beach County. Utilizing the previously mentioned selection criteria and geographical boundaries, the identification of 122 potential sites was possible in Palm Beach County.

Site Characteristics - The selected sites were then measured from copies of the REDI maps to determine size and perimeter. Site numbers and characteristics are provided in table 2 with most site locations being presented in figure 3. Exact site locations are not identified due to real estate requirements.

TABLE 2
PALM BEACH HARBOR
DISPOSAL AREA STUDY
SITE INFORMATION

SITE NUMBER	SITE SIZE (ACRES)	SITE NUMBER	SITE SIZE (ACRES)	SITE NUMBER	SITE SIZE (ACRES)	SITE NUMBER	SITE SIZE (ACRES)
PALM BEACH COUNTY, FL., NORTH VOLUME							
1	25	15	160	29	33	43	12
2	136	16	388	30	52	44	83
3	41	17	181	31	60	45	159
4	89	17A	11	32	35	46	315
5	110	18	126	33	28	47	267
6	112	19	25	34	96	48	147
7	350	20	272	35	78	49	57
8	232	21	523	36	44	50	19
8A	281	22	553	37	40	51	26
9	302	23	69	38	18	52	71
10	37	24	94	39	24	53	17
11	25	25	307	40	23	54	23
12	37	26	29	41	38	55	98
13	208	27	42	42	22	56	522
14	50	28	63	42A	12	57	68
						58	203
PALM BEACH COUNTY, FL., CENTRAL VOLUME							
59	47	74	12	89	221	104	38
60	27	75	22	90	45	105	14
61	15	76	316	91	53	106	13
62	153	77	39	92	47	107	148
63	117	78	49	93	35	108	27
64	60	79	51	94	26	109	22
65	155	80	14	95	140	110	169
66	86	81	24	96	93	111	24
67	54	82	19	97	27	112	14
68	94	83	121	98	13	113	12
69	54	84	28	99	131	114	20
70	108	85	101	100	186	115	16
71	89	86	19	101	13	116	20
72	275	87	33	102	12	117	17
73	19	88	65	103	152	118	14
						119	13

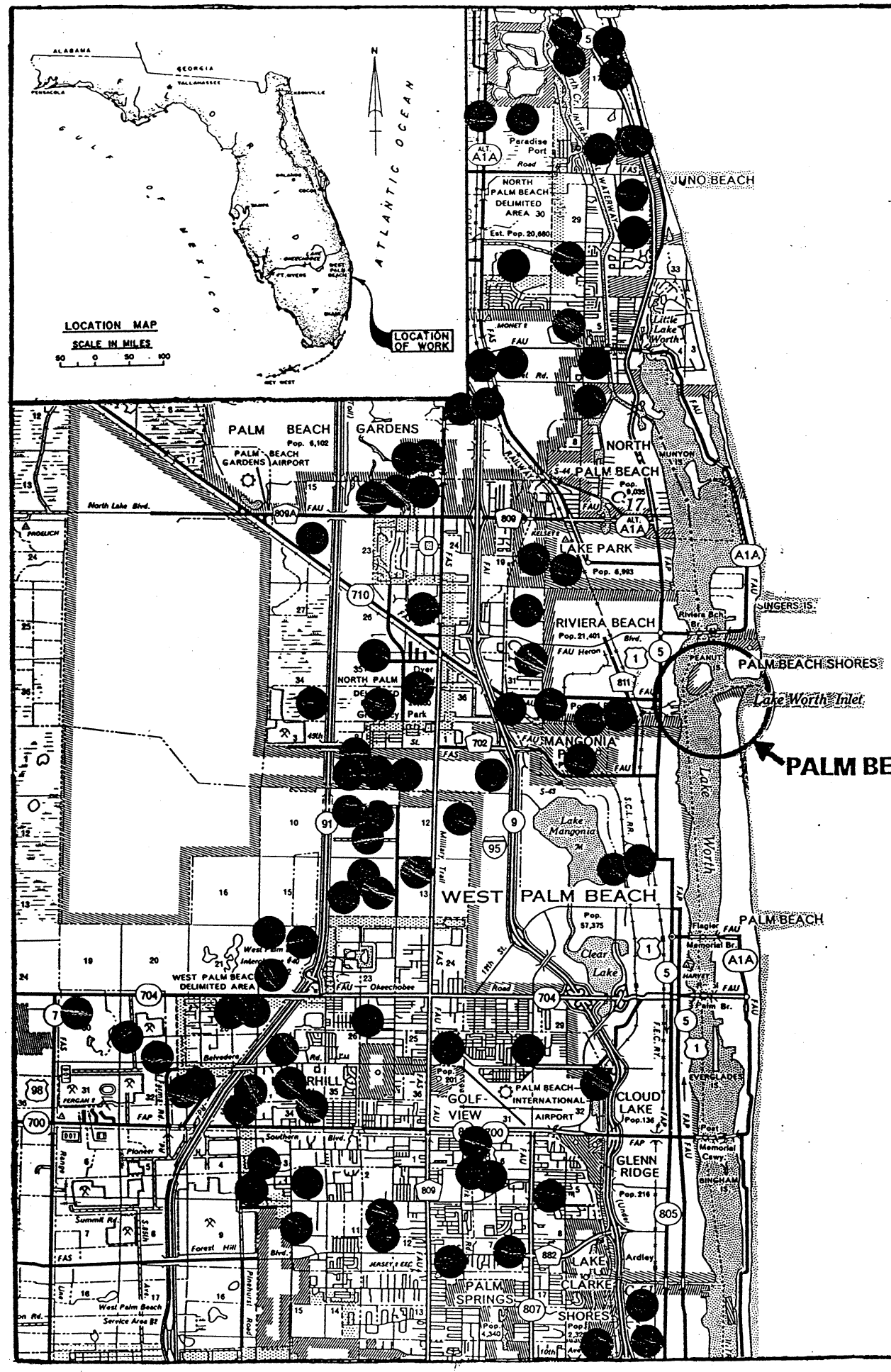
SITE VERIFICATION

Examination of aerial maps of each selected site enabled an environmental scientist to make initial observations concerning any significant environmental resources in the area. Any site with significant environmental resources was either dropped from consideration or redefined to avoid impacting those resources (see table 3). During initial site selection, the assumption was that each site remained as presented in the 1992 aerial maps and that pipeline access to each site would not prohibit site utilization. A site verification trip provided a more current identification and characterization of each site. The site inspection verified the land use and current conditions of the sites under consideration.

Changed Conditions - Site visits identified changes in site conditions that had taken place since the aerial photography was taken in 1992. Site visits to the potential sites revealed changes had taken place in one site. The southern part of site 38 has been developed into a self storage facility. However, this development has taken up only a small portion of site 38 with the remainder of this site still available for a disposal area. Visits to the remaining sites revealed no changes had occurred to make them unsuitable for disposal sites. The results of the site visits have verified that the potential sites are suitable for upland disposal areas.

Pipeline Access - An acceptable access route to the upland disposal site location is necessary. Access routes that must cross major highways, railroads, and other land parcels must take into account any environmental impacts and costs considerations to determine the practicality of such an action. Direct access to a site via an inland waterway is the most desired condition. Navigable waters of the United States do not require real estate easements. Small streams, canals, and drainage ditches can also provide access without an easement if they are attached to navigable waters. Access along highways and railroads is also possible and usually achieved by passing through culverts and under bridges. All potential sites have acceptable pipeline accessibility from adequate canals, drainage ditches, culverts, and bridges near the sites.

A potential site may be within the ten mile arc but a direct route to the site may not be available. In that case, the pipeline distance could exceed the ten mile limit and the site would be dropped from further consideration.



0 0.5 1 2 3 4 MILES
0 0.5 1 2 3 4 5 6 KILOMETERS
SCALE

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PALM BEACH HARBOR

FIGURE 3

LOCATION MAP

INITIAL UPLAND SITES

TABLE 3
PALM BEACH HARBOR DISPOSAL AREA STUDY
INITIAL UPLAND SITES ELIMINATED

SITE NUMBER	SITE SIZE (ACRES)	REASON FOR ELIMINATION
PALM BEACH COUNTY, FL., NORTH VOLUME		
1	25	PIPELINE DISTANCE > 10 MILES
2	136	PIPELINE DISTANCE > 10 MILES
3	41	PIPELINE DISTANCE > 10 MILES
4	89	PIPELINE DISTANCE > 10 MILES
5	110	PIPELINE DISTANCE > 10 MILES
6	112	PIPELINE DISTANCE > 10 MILES
7	350	PIPELINE DISTANCE > 10 MILES
8	232	PIPELINE DISTANCE > 10 MILES
8A	281	PIPELINE DISTANCE > 10 MILES
13	208	ENVIRONMENTAL CONCERNS
14	50	ENVIRONMENTAL CONCERNS
15	160	ENVIRONMENTAL CONCERNS
17	181	ENVIRONMENTAL CONCERNS
20	272	PIPELINE DISTANCE > 10 MILES
21	523	PIPELINE DISTANCE > 10 MILES
22	553	PIPELINE DISTANCE > 10 MILES
23	60	ENVIRONMENTAL CONCERNS
24	94	ENVIRONMENTAL CONCERNS
25	307	PIPELINE DISTANCE > 10 MILES
26	29	ENVIRONMENTAL CONCERNS
27	42	ENVIRONMENTAL CONCERNS
29	33	ENVIRONMENTAL CONCERNS
34	96	ENVIRONMENTAL CONCERNS
36	44	ENVIRONMENTAL CONCERNS
41	38	ENVIRONMENTAL CONCERNS
46	315	PIPELINE DISTANCE > 10 MILES
47	267	PIPELINE DISTANCE > 10 MILES
55	98	PIPELINE DISTANCE > 10 MILES
56	522	PIPELINE DISTANCE > 10 MILES
57	68	PIPELINE DISTANCE > 10 MILES
58	203	PIPELINE DISTANCE > 10 MILES
PALM BEACH COUNTY,FL., CENTRAL VOLUME		
59	47	ENVIRONMENTAL CONCERNS
60	27	PIPELINE DISTANCE > 10 MILES
61	15	PIPELINE DISTANCE > 10 MILES
62	153	PIPELINE DISTANCE > 10 MILES
63	117	PIPELINE DISTANCE > 10 MILES
64	60	PIPELINE DISTANCE > 10 MILES
65	155	ENVIRONMENTAL CONCERNS
66	86	ENVIRONMENTAL CONCERNS
67	54	ENVIRONMENTAL CONCERNS
68	94	PIPELINE DISTANCE > 10 MILES
69	54	PIPELINE DISTANCE > 10 MILES
70	108	ENVIRONMENTAL CONCERNS
71	89	PIPELINE DISTANCE > 10 MILES
72	275	ENVIRONMENTAL CONCERNS
73	19	PIPELINE DISTANCE > 10 MILES
74	12	PIPELINE DISTANCE > 10 MILES
75	22	PIPELINE DISTANCE > 10 MILES
76	316	ENVIRONMENTAL CONCERNS

TABLE 3
PALM BEACH HARBOR DISPOSAL AREA STUDY
INITIAL UPLAND SITES ELIMINATED

SITE NUMBER	SITE SIZE (ACRES)	REASON FOR ELIMINATION
PALM BEACH COUNTY, FL., CENTRAL VOLUME(Cont'd)		
77	39	PIPELINE DISTANCE > 10 MILES
78	49	PIPELINE DISTANCE > 10 MILES
79	51	PIPELINE DISTANCE > 10 MILES
80	14	PIPELINE DISTANCE > 10 MILES
81	24	PIPELINE DISTANCE > 10 MILES
82	19	PIPELINE DISTANCE > 10 MILES
83	121	PIPELINE DISTANCE > 10 MILES
84	28	PIPELINE DISTANCE > 10 MILES
85	64	PIPELINE DISTANCE > 10 MILES
86	19	PIPELINE DISTANCE > 10 MILES
87	33	PIPELINE DISTANCE > 10 MILES
88	65	PIPELINE DISTANCE > 10 MILES
89	221	PIPELINE DISTANCE > 10 MILES
90	45	ENVIRONMENTAL CONCERNS
91	53	PIPELINE DISTANCE > 10 MILES
92	47	PIPELINE DISTANCE > 10 MILES
93	35	PIPELINE DISTANCE > 10 MILES
94	26	PIPELINE DISTANCE > 10 MILES
95	140	PIPELINE DISTANCE > 10 MILES
96	93	PIPELINE DISTANCE > 10 MILES
97	27	PIPELINE DISTANCE > 10 MILES
98	13	PIPELINE DISTANCE > 10 MILES
99	131	PIPELINE DISTANCE > 10 MILES
100	186	PIPELINE DISTANCE > 10 MILES
101	13	ENVIRONMENTAL CONCERNS
102	12	PIPELINE DISTANCE > 10 MILES
103	152	PIPELINE DISTANVE > 10 MILES
104	38	ENVIRONMENTAL CONCERNS
105	14	ENVIRONMENTAL CONCERNS
106	13	PIPELINE DISTANVE > 10 MILES
107	148	PIPELINE DISTANCE > 10 MILES
108	27	PIPELINE DISTANCE > 10 MILES
109	22	PIPELINE DISTANCE > 10 MILES
110	169	PIPELINE DISTANCE > 10 MILES
111	24	PIPELINE DISTANCE > 10 MILES
112	14	PIPELINE DISTANCE > 10 MILES
113	12	ENVIRONMENTAL CONCERNS
114	20	PIPELINE DISTANCE > 10 MILES
115	16	PIPELINE DISTANCE > 10 MILES
116	20	PIPELINE DISTANCE > 10 MILES
117	17	PIPELINE DISTANCE > 10 MILES
118	14	ENVIRONMENTAL CONCERNS
119	13	ENVIRONMENTAL CONCERNS

DETAILED SITE ANALYSIS

The detailed site analysis considered the specific characteristics of each site in order to determine preparation requirements and capacity for material disposal. Preparation requirements included such items as clearing and grubbing, dike construction, and weir installation, all of which directly influence costs. Quantification of the work items enabled the development of costs for each site. The total estimated cost of all the work items to prepare a site is then divided by the site capacity to provide a cost per cubic yard ($/cy). Combining that unit cost with the dredging and real estate costs provides a total cost per cubic yard to utilize each site for disposal.

SITE SPECIFICS

An accurate determination of conditions at each site is essential in developing the correct site preparation cost. Site capacity depends upon the amount of usable area and dike heights at the site. Dike heights need to be established and the site area cleared for utilization. Each component is directly related to the utilization cost of a potential site.

Site Capacity - The volume of material that can be placed within the diked area is defined as the site capacity. Site capacity has three components, usable area within the dikes, dike height, and bulking factor. The sites were first identified in the initial site analysis and further reviewed during a field visit. The usable area has an influence on determining the dike height. Further engineering studies would determine the maximum dike height for each site. Most of the potential sites have acreages which could economically and engineeringly support dike heights of at least 20 feet. A freeboard of two feet in the dike height was a factor in estimating the site capacity. For a dike height of 20 feet, the freeboard consideration would limit material placement to a height of 18 feet. Material used for dike construction normally comes from inside the perimeter of the disposal area. The assumption is that each site has suitable material for dike construction. The dike material from inside the disposal area provides additional space for dredged material disposal. The bulking factor varies according to dredged material characteristics. Sand has a bulking factor of 1 while silt can have a bulking factor of 1.5. Based on previous dredging experience and the nature of the dredged material in the harbor, the bulking factor should be approximately 1.3. Based upon the above information, the estimated capacity of each potential site was calculated and is provided in table 4.

TABLE 4
PALM BEACH HARBOR DISPOSAL AREA STUDY
SITE INFORMATION

SITE NUMBER	PERIMETER LENGTH (YARDS)	SITE SIZE (ACRES)	DIKE HEIGHT (FT)	DIKE X-SECTION (SF)	DIKE QUANTITY (CY)	BULKING FACTOR	CAPACITY DIKED AREA (CY)
9	6,913	302	40	5,600	4,301,400	1.3	14,242,000
10	1,875	37	30	3,300	687,500	1.3	1,285,700
11	2,238	25	30	3,300	820,600	1.3	868,700
12	2,248	37	30	3,300	824,300	1.3	1,285,700
16	5,748	388	40	5,600	3,576,500	1.3	18,297,700
17A	998	11	20	1,600	177,400	1.3	245,700
18	3,668	126	40	5,600	2,282,300	1.3	5,942,000
19	1,560	25	30	3,300	572,000	1.3	868,700
28	3,268	63	40	5,600	2,033,400	1.3	2,971,000
30	2,080	52	40	5,600	1,294,200	1.3	2,452,300
31	2,249	60	40	5,600	1,399,400	1.3	2,829,500
32	1,935	42	40	5,600	1,204,000	1.3	1,980,700
33	1,802	28	30	3,300	660,700	1.3	973,000
35	3,268	78	40	5,600	2,033,400	1.3	3,678,400
37	1,907	40	40	5,600	1,186,600	1.3	1,886,400
38	1,462	38	30	3,300	536,100	1.3	1,320,500
39	1,393	24	30	3,300	510,800	1.3	834,000
40	1,505	23	30	3,300	551,800	1.3	799,200
42	1,384	22	30	3,300	507,500	1.3	764,500
42A	1,244	12	20	1,600	221,200	1.3	268,100
43	2,678	64	40	5,600	1,666,300	1.3	3,018,200
44	2,965	83	40	5,600	1,844,900	1.3	3,914,200
45	5,786	159	40	5,600	3,600,200	1.3	7,498,300
48	3,426	147	40	5,600	2,131,700	1.3	6,932,400
49	2,393	57	40	5,600	1,489,000	1.3	2,688,100
50	1,173	19	20	1,600	208,500	1.3	424,400
51	1,752	26	30	3,300	642,400	1.3	903,500
52	2,383	71	40	5,600	1,482,800	1.3	3,348,300
53	1,399	17	20	1,600	248,700	1.3	379,800
54	2,134	23	30	3,300	782,500	1.3	799,200

Site Preparation - Preparation of a potential site for use as a disposal area involves planning and design for dike construction, installation of water control structures (weirs), provisions for returning water from the site, and clearing the site of trees and brush for efficient use. The number of weirs required for a disposal area depends upon disposal area and dredge size. For sites in this study, the area in each is sufficient to accommodate a 30 inch hydraulic dredge. To handle the discharge water from that dredge, each site would need six weirs at a cost of $75,000 per unit. Site clearing costs depend upon the amount and density of trees and bushes to be removed from an area. Aerial photography and site visit was valuable in determining this factor at each site. Table 5 provides the range of costs for clearing and grubbing. Site 32 is an example for estimating the clearing and grubbing cost. The site is in a medium clearing category that is estimated to cost $89,460 to clear and grub. The value is derived from the 42 acres site size multiplied by the $2,130 per acre clearing category. The estimated cost for dike construction is $1.90 per cubic yard with the quantity provided in table 4. Mobilization and demobilization costs for moving equipment to and from the construction site also depends primarily upon the quantity of material needed for dike construction. Table 6 provides the range of costs employed for mobilization and demobilization. To cover the cost of uncertainties in the estimate, a contingency item is estimated at 25 percent of construction costs. Costs for engineering and design (E&D) and construction management (CM) are a percent of the total estimated construction costs. The combined percentage is 15.

Site Cost Summary - The purpose of the detailed site analysis is to determine the site preparation costs for disposal of dredged material. Table 7 provides a site cost summary for each element of cost associated with a potential upland disposal site. The last column in that table provides a cost per cubic yard of dredged material placed in each site. That unit cost is determined by dividing the total cost by the site capacity. The site cost is only a portion of the entire cost for upland disposal. The remaining facets of dredging and real estate are discussed in the following text.

EXISTING DISPOSAL AREAS

At the present time there are no existing disposal areas. Peanut Island has been used as a disposal area for maintenance material from the turning basin. However, Peanut Island is no longer available for a disposal area because it has been determined to have value for wildlife and recreational purposes. Maintenance material from the entrance and inner channels has been placed on the beach area south of the south jetty since the excavated material has been good quality sand.

TABLE 5
PALM BEACH HARBOR DISPOSAL AREA STUDY
CLEARING AND GRUBBING COST RANGES

CLEARING CATEGORY	COST PER ACRE
Light (no trees)	$ 560
Light (with trees)	1,230
Light to Medium	1,450
Medium	1,680
Medium to Heavy	2,130
Heavy	2,460

TABLE 6
PALM BEACH HARBOR DISPOSAL AREA STUDY
MOBILIZATION AND DEMOBILIZATION COST RANGES

CUBIC YARDS	COSTS
30,000 to 311,000	$ 56,000
312,000 to 1,099,000	112,000
1,100,000 to 1,299,000	168,000
1,300,000 to 5,000,000	224,000

TABLE 7
PALM BEACH HARBOR DISPOSAL AREA STUDY
SITE PREPARATION COSTS

SITE NUMBER	SITE SIZE (ACRES)	DIKE QUANTITY (CY)	MOB & DEMOB ($)	DIKE CONSTR ($)	CLEARING & GRUBBING ($)	CONTROL STRUCT ($)	SUBTOTAL ($)	CONTING @ 25% ($)	E&D AND CM @ 15% ($)	TOTAL ($)	DIKED AREA CAPACITY (CY)	COST ($/CY)
9	302	4,301,400	224,000	8,172,660	643,300	450,000	9,489,960	2,372,490	1,423,494	13,285,944	14,242,000	0.93
10	37	687,500	112,000	1,306,250	78,800	450,000	1,947,050	486,763	292,058	2,725,870	1,285,700	2.12
11	25	820,600	112,000	1,559,140	53,300	450,000	2,174,440	543,610	326,166	3,044,216	868,700	3.50
12	37	824,300	112,000	1,566,170	62,200	450,000	2,190,370	547,593	328,556	3,066,518	1,285,700	2.39
16	388	3,576,500	224,000	6,795,350	826,400	450,000	8,295,750	2,073,938	1,244,363	11,614,050	18,297,700	0.63
17A	11	177,400	56,000	337,060	18,500	450,000	861,560	215,390	129,234	1,206,184	245,700	4.91
18	126	2,282,300	224,000	4,336,370	268,400	450,000	5,278,770	1,319,693	791,816	7,390,278	5,942,000	1.24
19	25	572,000	112,000	1,086,800	53,300	450,000	1,702,100	425,525	255,315	2,382,940	868,700	2.74
28	63	2,033,400	224,000	3,863,460	91,400	450,000	4,628,860	1,157,215	694,329	6,480,404	2,971,000	2.18
30	52	1,294,200	168,000	2,458,980	87,400	450,000	3,164,380	791,095	474,657	4,430,132	2,452,300	1.81
31	60	1,399,400	224,000	2,658,860	100,800	450,000	3,433,660	858,415	515,049	4,807,124	2,829,500	1.70
32	42	1,204,000	168,000	2,287,600	89,500	450,000	2,995,100	748,775	449,265	4,193,140	1,980,700	2.12
33	28	660,700	112,000	1,255,330	59,600	450,000	1,876,930	469,233	281,540	2,627,702	973,000	2.70
35	78	2,033,400	224,000	3,863,460	166,100	450,000	4,703,560	1,175,890	705,534	6,584,984	3,678,400	1.79
37	40	1,186,600	168,000	2,254,540	58,000	450,000	2,930,540	732,635	439,581	4,102,756	1,886,400	2.17
38	38	536,100	112,000	1,018,590	80,900	450,000	1,661,490	415,373	249,224	2,326,086	1,320,500	1.76
39	24	510,800	112,000	970,520	29,500	450,000	1,562,020	390,505	234,303	2,186,828	834,000	2.62
40	23	551,800	112,000	1,048,420	33,400	450,000	1,643,820	410,955	246,573	2,301,348	799,200	2.88
42	22	507,500	112,000	964,250	37,000	450,000	1,563,250	390,813	234,488	2,188,550	764,500	2.86
42A	12	221,200	56,000	420,280	20,200	450,000	946,480	236,620	141,972	1,325,072	268,100	4.94
43	64	1,666,300	224,000	3,165,970	136,300	450,000	3,976,270	994,068	596,441	5,566,778	3,018,200	1.84
44	83	1,844,900	224,000	3,505,310	139,400	450,000	4,318,710	1,079,678	647,807	6,046,194	3,914,200	1.54
45	159	3,600,200	224,000	6,840,380	230,600	450,000	7,744,980	1,936,245	1,161,747	10,842,972	7,498,300	1.45
48	147	2,131,700	224,000	4,050,230	213,200	450,000	4,937,430	1,234,358	740,615	6,912,402	6,932,400	1.00
49	57	1,489,000	224,000	2,829,100	82,700	450,000	3,585,800	896,450	537,870	5,020,120	2,688,100	1.87
50	19	208,500	56,000	396,150	23,400	450,000	925,550	231,388	138,833	1,295,770	424,400	3.05
51	26	642,400	112,000	1,220,560	37,700	450,000	1,820,260	455,065	273,039	2,548,364	903,500	2.82
52	71	1,482,800	224,000	2,817,320	87,300	450,000	3,578,620	894,655	536,793	5,010,068	3,348,300	1.50
53	17	248,700	56,000	472,530	24,700	450,000	1,003,230	250,808	150,485	1,404,522	379,800	3.70
54	23	782,500	112,000	1,486,750	28,300	450,000	2,077,050	519,263	311,558	2,907,870	799,200	3.64

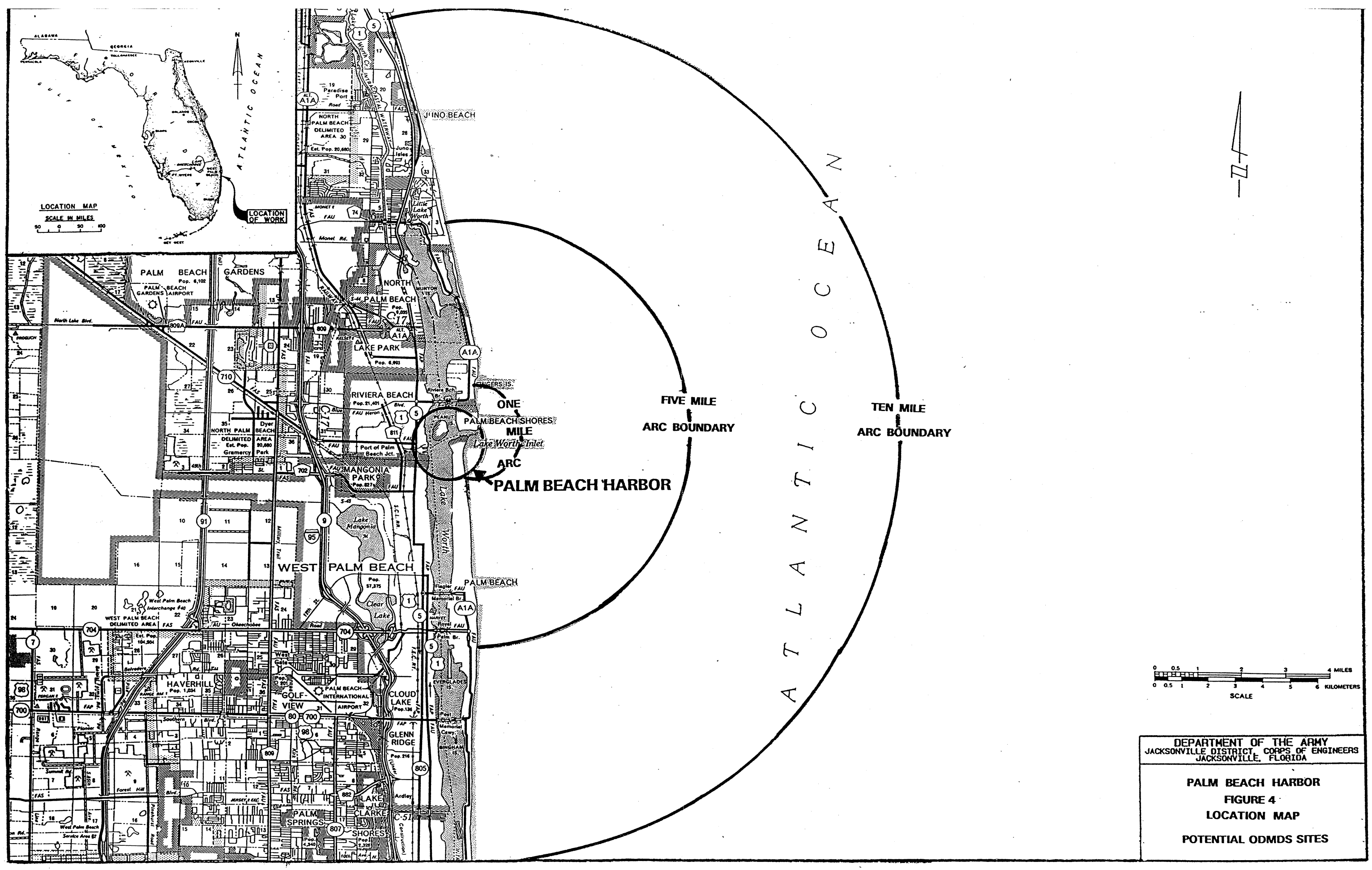
DETAILED DREDGING ANALYSIS

Dredging involves both the removal of material from the channel bottom and transportation to the designated disposal area. The analysis examined three methods of dredging. Clamshell dredging with barge transport and hopper dredging provide the most efficient methods to dispose of material in the offshore dredged material disposal site (ODMDS). Traditional hydraulic dredging with pipeline for transport to an upland site provides an efficient method for moving dredged material to upland disposal sites. As stated in the geographical boundaries section of this study, hydraulic dredging has a pumping limit of 10 miles which is based primarily on equipment limitations such as pipeline availability. Some respected experts in the dredging field consider a 5 mile maximum pumping distance as reasonable based upon the availability of pipeline. For this study, the limit was extended to ensure all possible alternatives for upland locations in the vicinity of Palm Beach Harbor received full consideration.

OCEAN DISPOSAL

The dredging analysis included two methods for ocean disposal of dredged material as mentioned earlier. Hopper dredging as well as clamshell dredging with barge transport are both applicable methods for ocean disposal. Currently, no usable ODMDS exists at Palm Beach Harbor. In order to determine cost for ocean disposal without a definite location for an ODMDS, cost estimates were computed for potential offshore sites in 1 mile increments from the Palm Beach Harbor entrance channel to 10 miles offshore. Figure 4 shows the location of the 1, 5, and 10 mile boundaries.

Hopper Dredge Estimates - The hopper dredge for estimating purposes has a carrying capacity of 3,600 cubic yards (cy). A hopper dredge hydraulically removes shoal material from the channel bottom and places it in a hopper on the dredge. When the hopper is full, the dredge proceeds to the ODMDS where the bottom of the hopper opens depositing the material on the ocean floor. The material classification which greatly influences dredging efficiency and therefore cost was discussed in the shoal characteristics section of this study. As stated in the same section, the project was broken into sections or cuts (see figure 2). A sample estimate to hopper dredge one of the Palm Beach Harbor cuts is provided in table 8. Note that the unit cost given at the top excludes any costs for mobilization, contingencies, engineering and design, as well as construction management. Table 9 provides the total dredging and transportation costs for each cut in the Palm Beach Harbor Federal Project. The costs for mobilization and demobilization are prorated over the project. Hopper dredge costs increase with with the distance to the ODMDS as shown in table 9.



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PALM BEACH HARBOR

FIGURE 4

LOCATION MAP

POTENTIAL ODMDS SITES

TABLE 8
PALM BEACH HARBOR
DISPOSAL AREA STUDY
HOPPER DREDGE ESTIMATE

CHECKLIST FOR INPUT DATA.
Planning Est. 12 July 94

PG 1 OF 14: PROJECT TITLES

BID QUANTITY	159,500 C.Y.
UNIT COST...	$3.55 PER C.Y.
EXCAV. COST.	$566,225
TIME.....	0.075 MONTHS

PROJECT -	Palm Beach Harbor DAS
LOCATION -	Ocean Disposal
INVIT # -	Turning Basin -> 10.0 miles
BID ITEM # -	2
FILENAME -	PBH401H
EST -	Al Fletcher
MIDPT DATE -	Oct-94
DESCRIPTION ENTERED? -	

PG 2 OF 14: EXCAVATION QTY'S

DREDGING AREA -	43,500 sf
REQ'D EXCAVATION -	15,950 cyds
% MUD -	50%
% SAND -	50%
% GRAVEL -	0%
PAY OVERDEPTH -	0 cyds
O.D. NOT DREDGED -	0 cyds
OVERDIG FOOTAGE -	1.00 ft
NONPAY YARDAGE -	16,100 cyds
GROSS YARDAGE -	175,600 cyds

PG 13 OF 14: MARKUPS USED

O.H. -	15.0%
PROFIT -	10.0%
BOND -	1.0%

PG 3 OF 14: LOCAL AREA FACTORS

FUEL COST -	$0.79 /gal
CFC RATE -	7.000%
USE MONTHS / YEAR -	10 mo/yr
MARINE INSUR -	1.5%
TAXES -	1.0%
PROVISIONS & SUPP -	$15 /man

PG 4 OF 14: DREDGE SELECTION (ALT-D)

DREDGE: SUGAR ISLAND

LOADS PER DAY -	5.67
CYCLE TIME -	216 min/load

PG'S 5-7 OF 14: PRODUCTION WORKSHEET

HOPPER CAPACITY -	3,600 cyds
EFF. HOPPER CAP. -	1,500 cyds
AVAIL DREDGING RATE -	2,100 cy/hr
AVAIL. DRAGHEADS -	2 ea
ACT. DRAGHDS USED -	1 ea
DRDGE RATE USED -	1,050 cy/hr
TURNS/CYCLE -	2 ea
MIN. PER TURN -	3 min
DISPOSAL DIST -	11.1 mi
TRVL SPD TO DISP -	10.8 mph
MAX TRVL SPD LOADED -	12.7 mph
DUMP/CONNECT TIME -	5 min
JET PUMP AVAIL? -	YES
TYPE OF DISPOSAL -	GRAVITY DUMP
PUMPING RATE -	cy/hr
TRVL SPD TO DREDG -	11.7 mph
MAX TRVL SPD LIGHT -	13.8 mph
EFFECTIVE TIME -	85.0%
OPER WORK DAYS/MO -	30.42 days
ADD. CLEANUP TIME -	10%
SPECIAL COST -	$7,000 /mo
SPECIAL COST -	$0 /job

PG'S 8-9 OF 14: PLANT OWN. & OPER.

DREDGE -	$361,328
PROPULSION TUG -	self prop.
SURVEY VESSEL -	$30,000
BOOSTER -	$0
CRANE BARGE -	$0
TENDER TUG -	$0
SHORE EQUIP -	$0

PG 14 OF 14: DREDGE OPER. ADJ. FACTORS

PUMP LOAD FACTOR -	50%
RPR & MAINT. ADJ -	1.00
JET PUMP % USAGE -	100%

PG'S 10-12 OF 14: LABOR, 24 Jun 88

OVERTIME % -	28.00%
VACATION/HOLIDAY % -	8.64%
TAX & INSUR % -	30.61%
FRINGE BENEFITS -	$4.35 /hr
DREDGE CREW:	
SUGG. CREW SIZE -	14 ea
USED CREW SIZE -	14 ea
SHORE CREW:	
USED CREW SIZE -	0 ea
GOVERNMENT PERSON -	3 ea
FRE. PD TRAVEL -	28 days
RT TRAVEL COST -	$400

TABLE 9
PALM BEACH HARBOR DISPOSAL AREA STUDY
HOPPER DREDGE AND OCEAN DISPOSAL COSTS

CUT NAME	SHOAL QUANTITY (CY)	MOB & DEMOB PER CUT	EXCAVATION COST PER CUT	SUBTOTAL COSTS PER CUT	CONT COSTS 25%	E&D AND CM 15%	HOPPER TOTAL $	DREDGING COSTS $/(CY)
1 MILE OFFSHORE								
TURNING BASIN	15,950	52,700	31,700	84,400	21,100	12,700	118,200	7.41
EXT TURNING BASIN	59,700	197,300	81,200	278,500	69,600	41,800	389,900	6.53
TOTALS – 1 MILE	75,650	250,000	112,900	362,900	90,700	54,500	508,100	
2 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	34,000	86,700	21,700	13,000	121,400	7.61
EXT TURNING BASIN	59,700	197,300	91,300	288,600	72,200	43,300	404,100	6.77
TOTALS – 2 MILES	75,650	250,000	125,300	375,300	93,900	56,300	525,500	
3 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	36,200	88,900	22,200	13,300	124,400	7.80
EXT TURNING BASIN	59,700	197,300	101,500	298,800	74,700	44,800	418,300	7.01
TOTALS – 3 MILES	75,650	250,000	137,700	387,700	96,900	58,100	542,700	
4 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	39,200	91,900	23,000	13,800	128,700	8.07
EXT TURNING BASIN	59,700	197,300	111,600	308,900	77,200	46,300	432,400	7.24
TOTALS – 4 MILES	75,650	250,000	150,800	400,800	100,200	60,100	561,100	
5 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	42,300	95,000	23,800	14,300	133,100	8.34
EXT TURNING BASIN	59,700	197,300	123,600	320,900	80,200	48,100	449,200	7.52
TOTALS – 5 MILES	75,650	250,000	165,900	415,900	104,000	62,400	582,300	
6 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	44,700	97,400	24,400	14,600	136,400	8.55
EXT TURNING BASIN	59,700	197,300	134,300	331,600	82,900	49,700	464,200	7.78
TOTALS – 6 MILES	75,650	250,000	179,000	429,000	107,300	64,300	600,600	
7 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	48,300	101,000	25,300	15,200	141,500	8.87
EXT TURNING BASIN	59,700	197,300	143,900	341,200	85,300	51,200	477,700	8.00
TOTALS – 7 MILES	75,650	250,000	192,200	442,200	110,600	66,400	619,200	
8 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	50,600	103,300	25,800	15,500	144,600	9.07
EXT TURNING BASIN	59,700	197,300	156,400	353,700	88,400	53,100	495,200	8.29
TOTALS – 8 MILES	75,650	250,000	207,000	457,000	114,200	68,600	639,800	
9 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	53,000	105,700	26,400	15,900	148,000	9.28
EXT TURNING BASIN	59,700	197,300	166,000	363,300	90,800	54,500	508,600	8.52
TOTALS – 9 MILES	75,650	250,000	219,000	469,000	117,200	70,400	656,600	
10 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	56,600	109,300	27,300	16,400	153,000	9.59
EXT TURNING BASIN	59,700	197,300	177,300	374,600	93,700	56,200	524,500	8.79
TOTALS – 10 MILES	75,650	250,000	233,900	483,900	121,000	72,600	677,500	
20 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	83,700	136,400	34,100	20,500	191,000	11.97
EXT TURNING BASIN	59,700	197,300	283,000	480,300	120,100	72,000	672,400	11.26
TOTALS – 20 MILES	75,650	250,000	366,700	616,700	154,200	92,500	863,400	

Clamshell Estimates - The clamshell dredging techniques are similar to the hopper dredge. The clamshell removes shoal material from the channel bottom which is deposited in an ocean going barge for transport to the ODMDS. One benefit of the clamshell operation is that with multiple barges the clamshell dredge can operate almost continuously. However, the additional equipment does cost more to mobilize to the dredging location. The clamshell dredge (26 cy) utilizes a 26 cy bucket to remove silty material and a 21 cy bucket to remove sandy material. The dredge is estimated to need two barges for transporting the material. The clamshell dredge works continuously. While one barge is enroute to the ODMDS, the clamshell is loading another barge. The number of barges influences the operating efficiency of the dredge. Table 10 provides a sample estimate summary similar to the hopper dredge estimate in table 8. Again, the mobilization and other costs absent in table 8 are also absent in the clamshell sample estimate. Table 11 provides the total dredging and transportation costs using a clamshell for each cut as shown in table 9. As with the hopper dredge costs, distance to the ODMDS is a factor influencing clamshell dredging costs.

UPLAND DISPOSAL

Upland disposal costs involved the traditional hydraulic dredging and transport to an upland site. As mentioned earlier, hydraulic dredging and material movement via pipeline has a 10 mile limit due to equipment limitations and dredging efficiencies. A pipeline access route was established to each potential upland site. The total cost for upland disposal includes dredging and transportation costs, site preparation cost, and site procurement cost. Further discussion of dredging and transportation costs is in the subsequent text.

Hydraulic Dredging - As stated throughout this report, hydraulic dredging is the traditional method for upland disposal and generally, the most economical for pumping distances less than 5 miles. This fact is possible because the dredge can work continuously without stopping to empty the hopper as with a hopper dredge or having to wait for a barge to return as with a clamshell dredge. A sample estimate for hydraulic dredging is given in table 12. The total cost is in table 13. The dredging costs shown in $ per cubic yard in table 13 reveal that potential disposal sites 9, 10, 11, 12, 16, 17A, 18, 19, 28, 30, 31, 39, 48, 50, 51, 52, 53, and 54 have significantly higher dredging costs than the rest of the potential sites. These sites were then dropped from further consideration. As described earlier, hydraulic dredging to a disposal site is restricted to a distance of approximately 10 miles. The mobilization cost for each maintenance event was prorated over the entire harbor. The assumption was made that maintenance of the turning basin areas would coincide with maintenance of the remainder of the harbor. Since the dredge and approximately 1.6 miles of pipe will be required to accomplish the beach placement only the mobilization costs for additional pipeline and booster pumps required for upland disposal where attributed to this portion of the study.

TABLE 10
PALM BEACH HARBOR
DISPOSAL AREA STUDY
MECHANICAL DREDGE ESTIMATE

CHECKLIST FOR INPUT DATA.

Palm Beach Harbor DAS

BID QUANTITY	15,942 C.Y.
UNIT COST...	$2.69 PER C.Y.
EXCAV. COST.	$42,884
TIME.....	0.07 MONTHS

PG 1 OF 9: PROJECT TITLES

FILENAME -	PBH401M
PROJECT -	Palm Beach Harbor DAS
LOCATION -	Ocean Disposal
INVIT # -	Turning Basin -> 10.0 miles
DATE OF EST. -	12 July 94
EST. BY -	Al Fletcher
MOB. BID ITEM # -	0
EXCAV. BID ITEM # -	0
TYPE OF EST. -	Planning Estimate

PG 2 OF 9: EXCAVATION QTY'S

DREDGING AREA -	43,514 sf
REQ'D EXCAVATION -	15,942 cyds
PAY OVERDEPTH -	0 cyds
CONTRACT AMOUNT -	15,942 cyds
NOT DREDGED -	0 cyds
NONPAY YARDAGE -	1,600 cyds
GROSS YARDAGE -	17,542 cyds
NONPAY HEIGHT -	1.0 ft overdig.
TOTAL BANK HEIGHT -	10.9 ft

PG 3 OF 9: EXCAVATION PRODUCTION WORKSHEET

DREDGE SELECTED -	21 CY Clamshell Dredge
TYPE OF MATERIAL -	SAND
BUCKET SIZE -	16
BUCKET FILL FACTOR -	0.70
OPTIMUM BANK -	8
BANK FACTOR -	1.00

PG 4 OF 9: EXCAVATION PRODUCTION WORKSHEET

BUCKET CYCLE TIME -	55 Seconds
OTHER FACTOR -	1.00 >
CLEANUP -	10% More Time
TIME EFFICIENCY -	65.0% of EWT

PG 5 OF 9: HAULING PRODUCTION WORKSHEET

TUG DESCRIPTION -	3000 HP Diesel--Twin Screw
PREPARE SCOW TOW -	15 min
HAUL DIST -	11.1 mi
SPEED TO D/A -	5 mph
SPEED FROM D/A -	6 mph

PG 5 OF 9: HAULING PRODUCTION WORKSHEET

DUMP OR PUMPOUT -	20 min
DISENGAGE TOW -	10 min
TOW EFFICIENCY -	80 %
SCOW DESCRIPTION -	3000 CY Split Hull Scow
USEABLE VOLUME -	90 %
% SOLIDS -	80 %

PG 6 OF 9: EQUIPMENT MATCHING

# OF PIECES:	Used
DREDGES -	1
SCOWS PER DREDGE -	1
TOWING VESSELS -	1
SCOWS PER TOW -	1
ADDITIONAL SCOWS -	0
TOT SCOWS ON JOB -	2

PG 7 OF 9: SPECIAL LABOR & EQUIPMENT

QUARTERS ON DREDGE? -	NO
SURVEY BOAT? -	YES
CREW BOAT? -	NO

PG 8 OF 9: LOCAL AREA FACTORS

PRESENT YEAR -	1993
ECONOMIC INDEX -	4718
LAF -	0.840
INTEREST RATE -	7.000% /yr
TIME PERIOD -	July to December, 1994
PLANT AVAILABLE -	10 mos/yr
FUEL PRICE -	$0.79 /gal

PG 9 OF 9: OTHER ADJUSTMENTS

SPECIAL COST/MO -	$7,000 Turbidity Monitoring
SPECIAL COST LS -	$0 >
CONTRACTOR'S O.H. -	15.0%
CONTRACTOR'S PROFIT -	10.0%
CONTRACTOR'S BOND -	1.0%

TABLE 11
PALM BEACH HARBOR DISPOSAL AREA STUDY
MECHANICAL DREDGE AND OCEAN DISPOSAL COSTS

CUT NAME	SHOAL QUANTITY (CY)	MOB & DEMOB PER CUT	EXCAVATION COST PER CUT	SUBTOTAL COSTS PER CUT	CONT COSTS 25%	E&D AND CM 15%	TOTAL $	DREDGING COSTS $/(CY)
1 MILE OFFSHORE								
TURNING BASIN	15,950	52,700	33,600	86,300	21,600	12,900	120,800	7.57
EXT TURNING BASIN	59,700	197,300	118,200	315,500	78,900	47,300	441,700	7.40
TOTALS – 1 MILE	75,650	250,000	151,800	401,800	100,500	60,200	562,500	
2 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	34,300	87,000	21,800	13,100	121,900	7.64
EXT TURNING BASIN	59,700	197,300	120,600	317,900	79,500	47,700	445,100	7.46
TOTALS – 2 MILES	75,650	250,000	154,900	404,900	101,300	60,800	567,000	
3 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	34,900	87,600	21,900	13,100	122,600	7.69
EXT TURNING BASIN	59,700	197,300	123,000	320,300	80,100	48,000	448,400	7.51
TOTALS – 3 MILES	75,650	250,000	157,900	407,900	102,000	61,100	571,000	
4 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	35,700	88,400	22,100	13,300	123,800	7.76
EXT TURNING BASIN	59,700	197,300	125,400	322,700	80,700	48,400	451,800	7.57
TOTALS – 4 MILES	75,650	250,000	161,100	411,100	102,800	61,700	575,600	
5 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	36,300	89,000	22,300	13,400	124,700	7.82
EXT TURNING BASIN	59,700	197,300	127,800	325,100	81,300	48,800	455,200	7.62
TOTALS – 5 MILES	75,650	250,000	164,100	414,100	103,600	62,200	579,900	
6 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	37,000	89,700	22,400	13,500	125,600	7.87
EXT TURNING BASIN	59,700	197,300	130,100	327,400	81,900	49,100	458,400	7.68
TOTALS – 6 MILES	75,650	250,000	167,100	417,100	104,300	62,600	584,000	
7 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	37,600	90,300	22,600	13,500	126,400	7.92
EXT TURNING BASIN	59,700	197,300	132,500	329,800	82,500	49,500	461,800	7.74
TOTALS – 7 MILES	75,650	250,000	170,100	420,100	105,100	63,000	588,200	
8 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	38,400	91,100	22,800	13,700	127,600	8.00
EXT TURNING BASIN	59,700	197,300	138,500	335,800	84,000	50,400	470,200	7.88
TOTALS – 8 MILES	75,650	250,000	176,900	426,900	106,800	64,100	597,800	
9 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	39,100	91,800	23,000	13,800	128,600	8.06
EXT TURNING BASIN	59,700	197,300	148,700	346,000	86,500	51,900	484,400	8.11
TOTALS – 9 MILES	75,650	250,000	187,800	437,800	109,500	65,700	613,000	
10 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	42,900	95,600	23,900	14,300	133,800	8.39
EXT TURNING BASIN	59,700	197,300	158,800	356,100	89,000	53,400	498,500	8.35
TOTALS – 10 MILES	75,650	250,000	201,700	451,700	112,900	67,700	632,300	
20 MILES OFFSHORE								
TURNING BASIN	15,950	52,700	67,800	120,500	30,100	18,100	168,700	10.58
EXT TURNING BASIN	59,700	197,300	259,100	456,400	114,100	68,500	639,000	10.70
TOTALS – 20 MILES	75,650	250,000	326,900	576,900	144,200	86,600	807,700	

TABLE 12
PALM BEACH HARBOR
DISPOSAL AREA STUDY
HYDRAULIC DREDGE ESTIMATE

CHECKLIST FOR INPUT DATA.

Palm Beach Harbor DAS

BID QUANTITY	15,942 C.Y.
UNIT COST...	$1.59 PER C.Y.
EXCAV. COST.	$25,348
TIME.....	0.02 MONTHS

PG 1 OF 9: PROJECT TITLES

FILENAME -	PBH401P
PROJECT -	Palm Beach Harbor DAS
LOCATION -	Site 45
INVIT # -	Turning Basin
DATE OF EST. -	12 July 94
EST. BY -	Al Fletcher & Tim Murphy
MOB. BID ITEM # -	0
EXCAV. BID ITEM # -	0
TYPE OF EST. -	Planning Estimate

PG 2 OF 9: EXCAVATION QTY'S

DREDGING AREA -	43,514 sf
REQ'D EXCAVATION -	15,942 cyds
PAY OVERDEPTH -	0 cyds
CONTRACT AMOUNT -	15,942 cyds
NOT DREDGED -	0 cyds
NONPAY YARDAGE -	1,600 cyds
GROSS YARDAGE -	17,542 cyds
NONPAY HEIGHT -	1.0 ft overdig.
TOTAL BANK HEIGHT -	10.9 ft

PG 3 OF 9: MAXIMUM PIPELINE REQUIRED

FLOATING -	2,000 ft
SUBMERGED -	31,300 ft
SHORE -	1,000 ft
TOTAL -	34,300 ft
COST CATEGORY -	2 SAND
EQUIVALENT -	0 ft

PG 4 OF 9: MATERIAL FACTOR

DESCRIPTION	FACTOR	PERCENTAGE
		%
MUD & SILT	3	0
MUD & SILT	2.5	50
MUD & SILT	2	0
LOOSE SAND	1.1	0
LOOSE SAND	1	50
COMP. SAND	0.9	0
STIFF CLAY	0.6	0
COMP. SHELL	0.5	0
SOFT ROCK	0.4	0
BLAST. ROCK	0.25	0

RESULTANT MATERIAL FACTOR -	1.43

PG 5 OF 9: DREDGE SELECTION

DREDGE SELECTED -	30" HYDRAULIC DREDGE
COMPUTED BANK FACTOR -	1.1
BANK FACTOR USED -	1.1 >
OTHER FACTOR -	1 >
CLEANUP -	10% More Time

PG 6 OF 9: HORSEPOWER CONSIDERATIONS

CHART H.P. -	9,000 hp
AVAILABLE H.P. -	9,000 hp
BOOSTER H.P. -	5,200 hp(ea)
LOSS PER BOOSTER -	15%

PG 7 OF 9: CHART PRODUCTION ANALYSIS

AVE. PIPELINE -	33,400 ft
BOOSTERS -	2
BOOSTER FACTOR -	0.70
% EFF WORK TIME (GROSS)-	65.0%
MAX. POSSIBLE -	63,526 ft
TOTAL HP AVAIL -	19,400 hp
% EFF WORK TIME (NET) -	45.5%
OPERATING TIME -	332 hours per month

PG 8 OF 9: GROSS PRODUCTION & LOCAL AREA FACTORS

PRODUCTION OVERRIDE -	NO
NET PRODUCTION -	2,134 net cy per hour
OPERATING TIME -	332 hours per month
BASED ON -	2 booster(s)
PAY PRODUCTION -	797,100 pay cy per month
PRESENT YEAR -	1993
ECONOMIC INDEX -	4718
LAF -	0.84
INTEREST RATE -	7.000% /yr
TIME PERIOD -	July to December, 1994
PLANT AVAILABLE -	9 mos/yr
FUEL PRICE -	$0.79 /gal

PG 9 OF 9: OTHER ADJUSTMENTS

SPECIAL COST/MO -	$7,000 Turbidity Monitoring
SPECIAL COST LS -	$0 >
CONTRACTOR'S O.H. -	15.0%
CONTRACTOR'S PROFIT -	10.0%
CONTRACTOR'S BOND -	1.0%

TABLE 13
PALM BEACH HARBOR DISPOSAL AREA STUDY
HYDRAULIC DREDGE AND UPLAND DISPOSAL COSTS

CUT NAME	SHOAL QUANTITY (CY)	MOB & DEMOB PER CUT	EXCAVATION COST PER CUT	SUBTOTAL COSTS PER CUT	CONT COSTS 25%	E&D AND CM 15%	TOTAL $	DREDGING COSTS $/(CY)
SITE 9								
TURNING BASIN	15,950	132,300	49,400	181,700	45,400	27,300	254,400	15.95
EXT TURNING BASIN	59,750	495,500	186,900	682,400	170,600	102,400	955,400	15.99
TOTALS – SITE 9	75,700	627,800	236,300	864,100	216,000	129,700	1,209,800	
SITE 10								
TURNING BASIN	15,950	108,700	39,200	147,900	37,000	22,200	207,100	12.98
EXT TURNING BASIN	59,750	407,100	170,100	577,200	144,300	86,600	808,100	13.52
TOTALS – SITE 10	75,700	515,800	209,300	725,100	181,300	108,800	1,015,200	
SITE 11								
TURNING BASIN	15,950	125,500	48,900	174,400	43,600	26,200	244,200	15.31
EXT TURNING BASIN	59,750	470,300	185,100	655,400	163,900	98,300	917,600	15.36
TOTALS – SITE 11	75,700	595,800	234,000	829,800	207,500	124,500	1,161,800	
SITE 12								
TURNING BASIN	15,950	127,600	49,100	176,700	44,200	26,500	247,400	15.51
EXT TURNING BASIN	59,750	478,200	185,700	663,900	166,000	99,600	929,500	15.56
TOTALS – SITE 12	75,700	605,800	234,800	840,600	210,200	126,100	1,176,900	
SITE 16								
TURNING BASIN	15,950	99,800	38,700	138,500	34,600	20,800	193,900	12.16
EXT TURNING BASIN	59,750	374,000	154,600	528,600	132,200	79,300	740,100	12.39
TOTALS – SITE 16	75,700	473,800	193,300	667,100	166,800	100,100	934,000	
SITE 17A								
TURNING BASIN	15,950	128,900	49,100	178,000	44,500	26,700	249,200	15.62
EXT TURNING BASIN	59,750	482,900	186,300	669,200	167,300	100,400	936,900	15.68
TOTALS – SITE 17A	75,700	611,800	235,400	847,200	211,800	127,100	1,186,100	
SITE 18								
TURNING BASIN	15,950	128,500	49,100	177,600	44,400	26,600	248,600	15.59
EXT TURNING BASIN	59,750	481,300	185,700	667,000	166,800	100,100	933,900	15.63
TOTALS – SITE 18	75,700	609,800	234,800	844,600	211,200	126,700	1,182,500	
SITE 19								
TURNING BASIN	15,950	109,900	39,400	149,300	37,300	22,400	209,000	13.10
EXT TURNING BASIN	59,750	411,900	170,100	582,000	145,500	87,300	814,800	13.64
TOTALS – SITE 19	75,700	521,800	209,500	731,300	182,800	109,700	1,023,800	
SITE 28								
TURNING BASIN	15,950	113,300	39,400	152,700	38,200	22,900	213,800	13.40
EXT TURNING BASIN	59,750	424,500	170,100	594,600	148,700	89,200	832,500	13.93
TOTALS – SITE 28	75,700	537,800	209,500	747,300	186,900	112,100	1,046,300	
SITE 30								
TURNING BASIN	15,950	98,100	38,600	136,700	34,200	20,500	191,400	12.00
EXT TURNING BASIN	59,750	367,700	145,100	512,800	128,200	76,900	717,900	12.02
TOTALS – SITE 30	75,700	465,800	183,700	649,500	162,400	97,400	909,300	
SITE 31								
TURNING BASIN	15,950	109,100	39,200	148,300	37,100	22,200	207,600	13.02
EXT TURNING BASIN	59,750	408,700	170,100	578,800	144,700	86,800	810,300	13.56
TOTALS – SITE 31	75,700	517,800	209,300	727,100	181,800	109,000	1,017,900	
SITE 32								
TURNING BASIN	15,950	73,000	37,600	110,600	27,700	16,600	154,900	9.71
EXT TURNING BASIN	59,750	273,300	128,400	401,700	100,400	60,300	562,400	9.41
TOTALS – SITE 32	75,700	346,300	166,000	512,300	128,100	76,900	717,300	
SITE 33								
TURNING BASIN	15,950	49,300	24,100	73,400	18,400	11,000	102,800	6.45
EXT TURNING BASIN	59,750	184,500	108,100	292,600	73,200	43,900	409,700	6.86
TOTALS – SITE 33	75,700	233,800	132,200	366,000	91,600	54,900	512,500	
SITE 35								
TURNING BASIN	15,950	46,700	23,900	70,600	17,700	10,600	98,900	6.20
EXT TURNING BASIN	59,750	175,100	95,500	270,600	67,700	40,600	378,900	6.34
TOTALS – SITE 35	75,700	221,800	119,400	341,200	85,400	51,200	477,800	
SITE 37								
TURNING BASIN	15,950	70,300	25,300	95,600	23,900	14,300	133,800	8.39
EXT TURNING BASIN	59,750	263,500	123,600	387,100	96,800	58,100	542,000	9.07
TOTALS – SITE 37	75,700	333,800	148,900	482,700	120,700	72,400	675,800	

TABLE 13
PALM BEACH HARBOR DISPOSAL AREA STUDY
HYDRAULIC DREDGE AND UPLAND DISPOSAL COSTS

CUT NAME	SHOAL QUANTITY (CY)	MOB & DEMOB PER CUT	EXCAVATION COST PER CUT	SUBTOTAL COSTS PER CUT	CONT COSTS 25%	E&D AND CM 15%	TOTAL $	DREDGING COSTS $/(CY)
SITE 38								
TURNING BASIN	15,950	73,800	37,800	111,600	27,900	16,700	156,200	9.79
EXT TURNING BASIN	59,750	276,500	128,400	404,900	101,200	60,700	566,800	9.49
TOTALS – SITE 38	75,700	350,300	166,200	516,500	129,100	77,400	723,000	
SITE 39								
TURNING BASIN	15,950	93,100	38,300	131,400	32,900	19,700	184,000	11.54
EXT TURNING BASIN	59,750	348,700	143,300	492,000	123,000	73,800	688,800	11.53
TOTALS – SITE 39	75,700	441,800	181,600	623,400	155,900	93,500	872,800	
SITE 40								
TURNING BASIN	15,950	76,800	38,100	114,900	28,700	17,200	160,800	10.08
EXT TURNING BASIN	59,750	287,500	129,000	416,500	104,100	62,500	583,100	9.76
TOTALS – SITE 40	75,700	364,300	167,100	531,400	132,800	79,700	743,900	
SITE 42								
TURNING BASIN	15,950	74,200	37,800	112,000	28,000	16,800	156,800	9.83
EXT TURNING BASIN	59,750	278,100	128,400	406,500	101,600	61,000	569,100	9.52
TOTALS – SITE 42	75,700	352,300	166,200	518,500	129,600	77,800	725,900	
SITE 42A								
TURNING BASIN	15,950	74,200	37,800	112,000	28,000	16,800	156,800	9.83
EXT TURNING BASIN	59,750	278,100	128,400	406,500	101,600	61,000	569,100	9.52
TOTALS – SITE 42A	75,700	352,300	166,200	518,500	129,600	77,800	725,900	
SITE 43								
TURNING BASIN	15,950	74,000	37,800	111,800	28,000	16,800	156,600	9.82
EXT TURNING BASIN	59,750	277,300	128,400	405,700	101,400	60,900	568,000	9.51
TOTALS – SITE 43	75,700	351,300	166,200	517,500	129,400	77,700	724,600	
SITE 44								
TURNING BASIN	15,950	77,200	38,100	115,300	28,800	17,300	161,400	10.12
EXT TURNING BASIN	59,750	289,100	129,000	418,100	104,500	62,700	585,300	9.80
TOTALS – SITE 44	75,700	366,300	167,100	533,400	133,300	80,000	746,700	
SITE 45								
TURNING BASIN	15,950	70,300	25,300	95,600	23,900	14,300	133,800	8.39
EXT TURNING BASIN	59,750	263,500	123,600	387,100	96,800	58,100	542,000	9.07
TOTALS – SITE 45	75,700	333,800	148,900	482,700	120,700	72,400	675,800	
SITE 48								
TURNING BASIN	15,950	100,700	38,700	139,400	34,900	20,900	195,200	12.24
EXT TURNING BASIN	59,750	377,100	154,600	531,700	132,900	79,800	744,400	12.46
TOTALS – SITE 48	75,700	477,800	193,300	671,100	167,800	100,700	939,600	
SITE 49								
TURNING BASIN	15,950	75,900	37,900	113,800	28,500	17,100	159,400	9.99
EXT TURNING BASIN	59,750	284,400	129,000	413,400	103,400	62,000	578,800	9.69
TOTALS – SITE 49	75,700	360,300	166,900	527,200	131,900	79,100	738,200	
SITE 50								
TURNING BASIN	15,950	131,400	49,300	180,700	45,200	27,100	253,000	15.86
EXT TURNING BASIN	59,750	492,400	186,900	679,300	169,800	101,900	951,000	15.92
TOTALS – SITE 50	75,700	623,800	236,200	860,000	215,000	129,000	1,204,000	
SITE 51								
TURNING BASIN	15,950	104,000	38,900	142,900	35,700	21,400	200,000	12.54
EXT TURNING BASIN	59,750	389,800	160,000	549,800	137,500	82,500	769,800	12.88
TOTALS – SITE 51	75,700	493,800	198,900	692,700	173,200	103,900	969,800	
SITE 52								
TURNING BASIN	15,950	108,300	39,200	147,500	36,900	22,100	206,500	12.95
EXT TURNING BASIN	59,750	405,500	169,500	575,000	143,800	86,300	805,100	13.47
TOTALS – SITE 52	75,700	513,800	208,700	722,500	180,700	108,400	1,011,600	
SITE 53								
TURNING BASIN	15,950	124,700	48,800	173,500	43,400	26,000	242,900	15.23
EXT TURNING BASIN	59,750	467,100	184,500	651,600	162,900	97,700	912,200	15.27
TOTALS – SITE 53	75,700	591,800	233,300	825,100	206,300	123,700	1,155,100	
SITE 54								
TURNING BASIN	15,950	95,600	38,400	134,000	33,500	20,100	187,600	11.76
EXT TURNING BASIN	59,750	358,200	143,900	502,100	125,500	75,300	702,900	11.76
TOTALS – SITE 54	75,700	453,800	182,300	636,100	159,000	95,400	890,500	

REAL ESTATE VALUES

The following evaluations involve an assessment of real estate values on the upland sites. The real estate analysis is last because of the field work involved in obtaining estimates for each site. Engineering and environmental investigations reduced the number of sites prior to initiating the real estate analysis. The real estate evaluations are in Appendix A and the results are in table 14. The estimated real estate values are for a fee simple purchase of the site. The values do not include any easements required for pipeline access to the site. Appendix A provides details concerning the methods used to obtain the real estate values as well as assumptions and limitations of the analysis.

COST COMPARISON

The estimated real estate costs were added to the previously calculated total costs for dredging and upland disposal for each site. Dredging costs for each of the ocean disposal methods provided a base condition for comparison with potential upland sites to determine at this level of detail what upland areas appear feasible for future consideration. The ocean disposal costs in tables 9 and 11 provide the base costs for comparison with total dredging and site preparation cost on a site by site basis. Table 15 uses site 45 as a sample of the comparison generated for each potential upland site. The most economical alternative is identified with an "*". The cost comparison for all potential sites produced no upland site that was as economical as offshore disposal.

SENSITIVITY ANALYSIS

The method of cost analysis lends itself to sensitivity of several cost elements. The real estate cost for each potential site was reduced by 50 percent. The results still indicated that no upland site was as economical as utilization of an ODMDS located up to 10 miles offshore. A series of cost estimates were compiled based upon hopper dredging and disposal in an ODMDS located 20 miles offshore. The results were identical to the previous sensitivity analysis performed for real estate costs.

TABLE 14
PALM BEACH HARBOR DISPOSAL AREA STUDY
REAL ESTATE VALUES

SITE NUMBER	SITE SIZE (ACRES)	DIKED AREA CAPACITY (CY)	TOTAL COMPENSATORY VALUE ($)	($/CY)
9	302	14,242,000	NA	0.00
10	37	1,285,700	NA	0.00
11	25	868,700	NA	0.00
12	37	1,285,700	NA	0.00
16	388	18,297,700	NA	0.00
17A	11	245,700	NA	0.00
18	126	5,942,000	NA	0.00
19	25	868,700	NA	0.00
28	63	2,971,000	NA	0.00
30	52	2,452,300	NA	0.00
31	60	2,829,500	NA	0.00
32	42	1,980,700	4,055,000	2.05
33	28	973,000	3,459,000	3.55
35	78	3,678,400	10,730,000	2.92
37	40	1,886,400	5,340,000	2.83
38	38	1,320,500	1,790,000	1.36
39	24	834,000	NA	0.00
40	23	799,200	9,330,000	11.67
42	22	764,500	1,691,000	2.21
42A	12	268,100	923,000	3.44
43	64	3,018,200	71,700	0.02
44	83	3,914,200	5,500,000	1.41
45	159	7,498,300	3,404,000	0.45
48	147	6,932,400	NA	0.00
49	57	2,688,100	5,341,000	1.99
50	19	424,400	NA	0.00
51	26	903,500	NA	0.00
52	71	3,348,300	NA	0.00
53	17	379,800	NA	0.00
54	23	799,200	NA	0.00

TABLE 15
PALM BEACH HARBOR DISPOSAL AREA STUDY
COST COMPARISON

CUT NAME	QUANTITY PER CUT (CY)	COSTS PER DREDGE AND DISPOSAL TYPE ($/CY) CLAMSHELL TO OCEAN	HOPPER TO OCEAN	HYDRAULIC TO SITE 45
PALM BEACH HARBOR				
TURNING BASIN	15,950	$8.39 *	$9.59	$10.28
EXT TURNING BASIN	59,750	$8.35 *	$8.79	$10.96

* – Most Economical Dredging Method Per Cut

SUMMARY

The initial analysis involved 122 potential upland disposal sites located within a 10 mile arc of the Palm Beach Harbor Turning Basin. Environmental evaluations determined that 26 sites were unsuitable for disposal. After establishing pipeline access routes to each site, 66 sites were in excess of the 10 mile pipeline limit and removed from further consideration. An examination of hydraulic dredge and upland disposal costs of the remaining 30 potential disposal sites are summarized in table 16. From that table 18 sites have a cost for disposal of over $13.60 which is very high. Removing those sites from further consideration leaves 12 disposal areas which still exceed the cost for using either ODMDS site. Those 12 sites could be a consideration for disposal of material which is unsuitable for placement in the ODMDS.

During the course of this study, the preparation of over 80 cost estimates enabled a detailed cost comparison between 3 possible dredging techniques. This report shows only a sampling of those estimates. Detailed documentation on the estimates is available in the Jacksonville District Office.

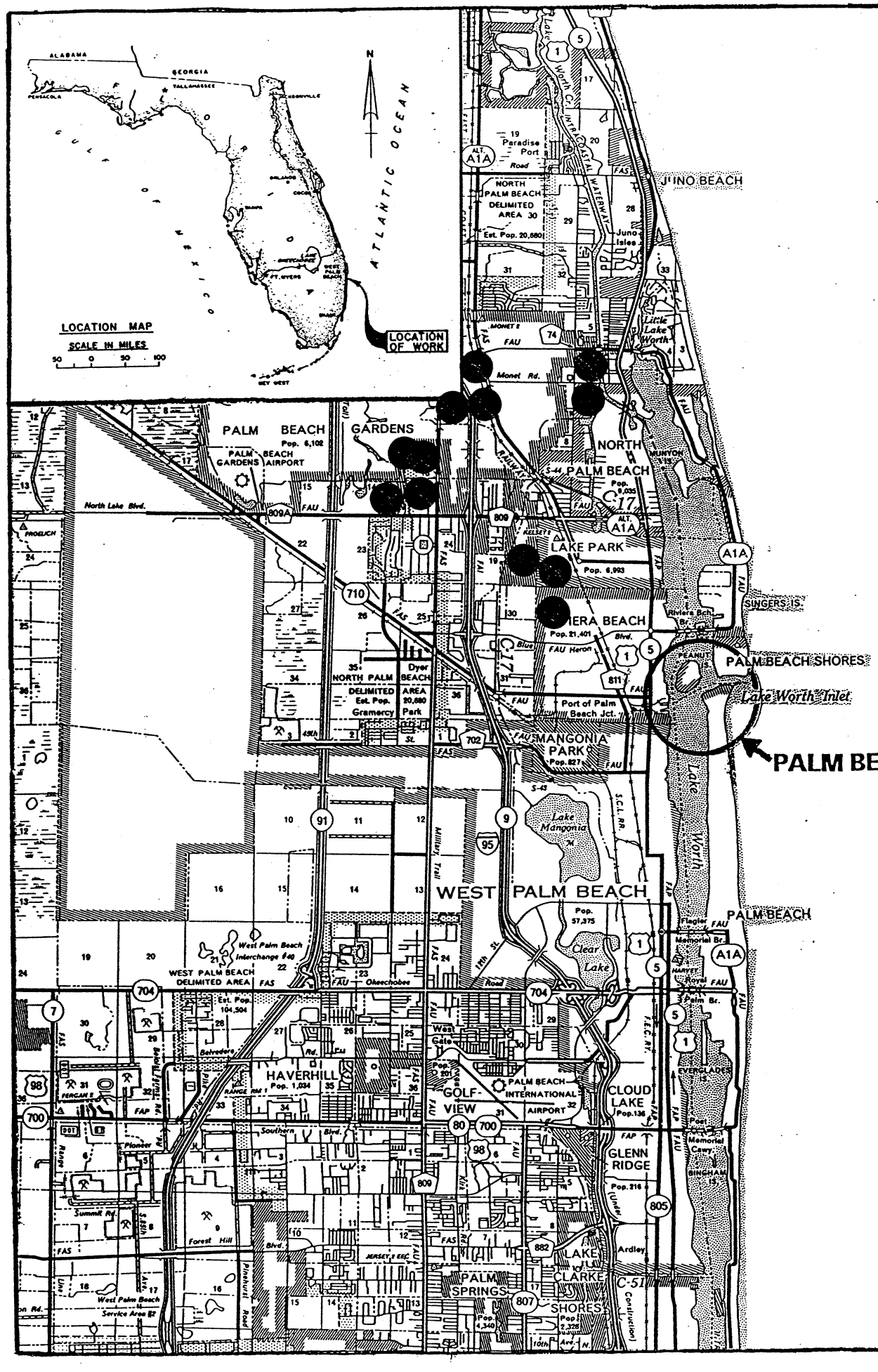
RESULTS

The results presented in tables 15 and 16 demonstrate the need for an Ocean Dredged Material Disposal Site (ODMDS) for the Palm Beach Harbor Federal Project. As shown by table 16, no upland disposal sites were found to be more economical than the use of the ODMDS. However, 12 potential upland sites do exist if the material that does not meet EPA criteria (see table 16).

TABLE 16
PALM BEACH HARBOR DISPOSAL AREA STUDY
FINAL COST COMPARISION

SITE NUMBER	CAPACITY	TURNING BASIN QUANTITY (CY)	TURNING BASIN COSTS ($/CY)	EXT TURNING BASIN QUANTITY (CY)	EXT TURNING BASIN COSTS ($/CY)	PROJECT COSTS ($)	NOTES
ODMDS @ 10 MILES WITH HOPPER DREDGE							
ODMDS	UNLIMITED	15,950	9.59	59,700	8.79	678,000	
ODMDS @ 10 MILES WITH CLAMSHELL DREDGE							
ODMDS	UNLIMITED	15,950	8.39	59,700	8.35	632,000	1
UPLAND DISPOSAL SITES WITH HYDRAULIC DREDGE							
9	14,242,000	15,950	16.38	59,700	16.43	1,242,000	2
10	1,285,700	15,950	14.61	59,700	15.16	1,138,000	2
11	868,700	15,950	18.32	59,700	18.37	1,389,000	2
12	1,285,700	15,950	17.42	59,700	17.46	1,320,000	2
16	18,297,700	15,950	12.31	59,700	12.53	945,000	2
17A	245,700	15,950	20.04	59,700	20.10	1,520,000	2
18	5,942,000	15,950	16.34	59,700	16.38	1,239,000	2
19	868,700	15,950	15.37	59,700	15.89	1,194,000	2
28	2,971,000	15,950	15.10	59,700	15.62	1,173,000	2
30	2,452,300	15,950	13.33	59,700	13.34	1,009,000	2
31	2,829,500	15,950	14.23	59,700	14.77	1,109,000	2
32	1,980,700	15,950	13.38	59,700	13.08	995,000	
33	973,000	15,950	12.22	59,700	12.63	949,000	
35	3,678,400	15,950	10.43	59,700	10.56	797,000	
37	1,886,400	15,950	12.92	59,700	13.59	1,017,000	
38	1,320,500	15,950	12.42	59,700	12.12	921,000	
39	834,000	15,950	13.67	59,700	13.66	1,034,000	2
40	799,200	15,950	24.14	59,700	23.82	1,807,000	
42	764,500	15,950	14.42	59,700	14.10	1,072,000	
42A	268,100	15,950	17.74	59,700	17.42	1,323,000	
43	3,018,200	15,950	11.20	59,700	10.89	829,000	
44	3,914,200	15,950	12.58	59,700	12.26	933,000	
45	7,498,300	15,950	9.81	59,700	10.48	782,000	
48	6,932,400	15,950	12.75	59,700	12.97	977,000	2
49	2,688,100	15,950	13.35	59,700	13.05	992,000	
50	424,400	15,950	18.43	59,700	18.48	1,397,000	2
51	903,500	15,950	14.88	59,700	15.21	1,145,000	2
52	3,348,300	15,950	13.96	59,700	14.49	1,087,000	2
53	379,800	15,950	18.44	59,700	18.48	1,397,000	2
54	799,200	15,950	14.92	59,700	14.92	1,129,000	2

NOTE:
1. The most economical alternative for project maintenance is an ODMDS located up to 10 miles offshore.
2. No real estate values included in project cost.



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PALM BEACH HARBOR

FIGURE 5

LOCATION MAP

POTENTIAL UPLAND SITES

PALM BEACH HARBOR DISPOSAL AREA STUDY

REAL ESTATE SECTION

ATTACHMENT A

PALM BEACH HARBOR DISPOSAL AREA STUDY
REAL ESTATE SECTION FOR
POTENTIAL UPLAND DISPOSAL SITES

PURPOSE

The purpose of this study is to investigate potential upland disposal sites to be utilized in conjunction with the Palm Beach Harbor Dredging project. (Refer to Figure 3 for locations of potential sites.)

DESCRIPTION OF STUDY AND STUDY AREA

Twelve sites were selected as suitable for potential upland disposal sites. Each site was evaluated by the appraiser to arrive at an estimate of value for each disposal site. The estimates will enable a comparison of cost between the use of upland sites and the offshore disposal option.

The study area encompasses municipalities in Palm Beach County. The identified potential upland disposal sites are located in Palm Beach County. Potential disposal sites were located through the use of past studies, aerial photography, and geographical limitations. Each site is required to be open land with no dwellings, to meet minimum size requirement of 10 acres, and to be within the maximum pumping distance of approximately 10 miles from the dredge location. The geographical area is roughly bounded by the Atlantic Ocean to the east and a 10 mile arc from the Palm Beach Harbor Turning Basin formed the North, West, and South boundaries. These restrictions and boundaries have limited the scope of the study. The overall area is urbanized, with a mix of residential, commercial, agricultural, and industrial land use.

ESTIMATE OF VALUES

Each potential site was valued in fee simple based on recent tax assessment data and sales information. The indicated values are estimates for each potential site at the date of this study. A more detailed analysis would be necessary if consideration was given beyond the potential analysis stage. The Palm Beach Harbor Disposal Area Study Real Estate Values are provided in Table A-1.

TABLE A–1
PALM BEACH HARBOR
DISPOSAL AREA STUDY
REAL ESTATE VALUES

SITE NUMBER	SITE SIZE (ACRES)	TOTAL COMPENSATORY VALUE ($)
32	42	4,055,000
33	28	3,459,000
35	78	10,730,000
37	40	5,340,000
38	38	1,790,000
40	23	9,330,000
42	22	1,691,000
42A	12	923,000
43	64	71,700
44	83	5,500,000
45	159	3,404,000
49	57	5,341,000

The valuations as presented in this Real Estate Section are based upon information and conditions existing during the study period and are preliminary. A more detailed real estate study will be required to implement any upland site recommended in this report.necessary. Access routes that must cross major highways, railroads, and other land parcels must take into account any environmental impacts and costs considerations to determine the practicality of such an action. Direct access to a site via an inland waterway is the most desired condition. Navigable waters of the United States do not require real estate easements. Small streams, canals, and drainage ditches can also provide access without an easement if they are attached to navigable waters. Access along highways and railroads is also possible and usually achieved by passing through culverts and under bridges.

A potential site may be within the ten mile arc but a direct route to the site may not be available. In that case, the pipeline distance could exceed the ten mile limit and the site would be dropped from further consideration.